

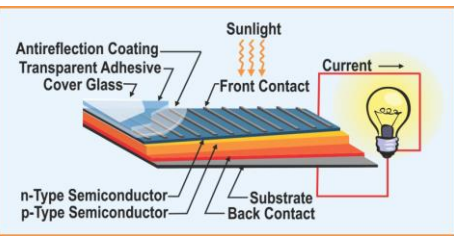


## Overview

PV is a renewable energy technology that converts solar radiation directly into electricity. Solar energy is abundant; the energy that the Earth receives from the Sun every hour is equal to the world's annual energy needs.

### How PV Works:

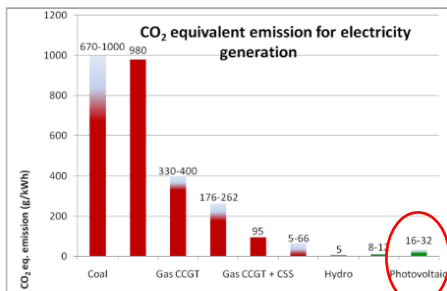
1. Sunlight strikes a PV cell
2. Electric current is produced by stimulating electrons in the layer designed to give up electrons easily
3. The existing electric field in the solar cell pulls these electrons to another layer
4. Connecting the cell to an external load the current can be used to power the load



## Benefits, Policy, & the Future

### Greenhouse Gas Emissions:

- No global warming emissions with generating electricity from solar energy
- There are emissions associated with other stages of solar life cycle ex. manufacturing
- Estimates of life cycle emission between .07 and .18 pounds of CO<sub>2</sub>



Source: "The Carbon Footprint." EPIA, Sustainability of Photovoltaics Systems - Mar 2011.

### Policy:

- The Energy Policy Act of 2005 calls for an increase in the percentage of electricity generated from renewable sources to 10% by the year 2020
- Investment in and use of renewable energy has been encouraged with a range of state and federal government incentives
- Federal government is supporting renewable through a mix of tax credits, rebates and support for R&D

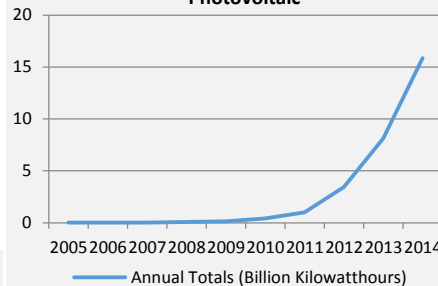
### The Future:

- The carbon footprint of PV electricity is continually decreasing and PV is increasing its share in the overall electricity mix.
- The energy used to produce PV systems results in a smaller carbon footprint environment, pushing a beneficiary self-cleaning circle towards a clean & sustainable future.

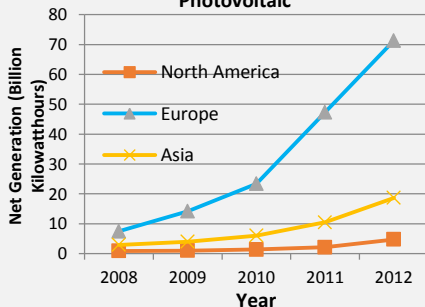
## PV Trends – US & Global

- The US is increasing its usage of solar photovoltaic over the last 5 years
- The increase has been growing exponentially over those years
- The expectation is that it will continue at that rate or greater as US policy promotes the use of renewable energy and specifically solar photovoltaic both residentially and commercially

### U.S Net Generation from Solar Photovoltaic

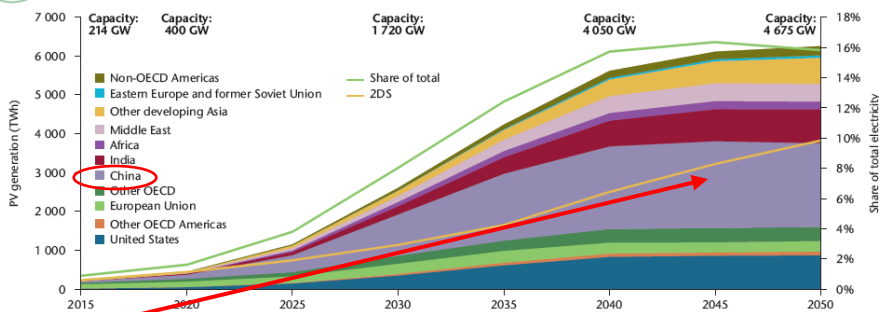


### Global Net Generation from Solar Photovoltaic



- The Global Net Generation from Solar Photovoltaic is also increasing and at a much faster pace than the US
- Europe specifically is setting policy to greatly promote renewable energy and is outpacing both Asia and North America's growth

## Regional electricity production from solar PV in TWh and share of global electricity



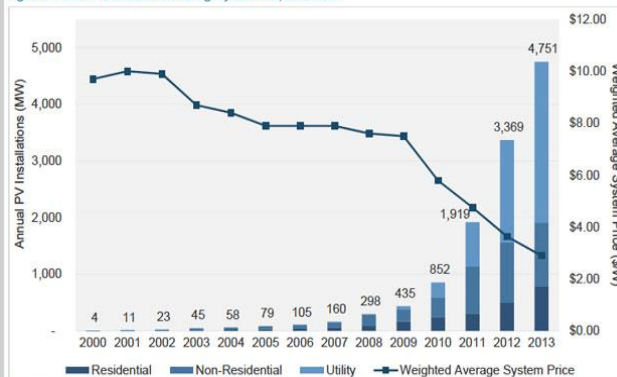
### China:

- In August 2014, Chinese government announced that it would ban the use of coal in Beijing by the end of 2020
- In the first 6 months of 2014, China added 3.3 gigawatts of solar capacity, double the additions over the same period in 2013.
- That brings China's total solar power supply up to 23 GW, second only to Germany's 36 GW, and just 12 GW under the country's goal of having 35 GW of solar installed by 2015.

## Costs

- The costs for energy from solar photovoltaic was originally considered to be cost prohibitive.
- In 2000, the cost was estimated at \$10/W and there were 1MW residential and 2MW non-residential installations.
- Rapidly falling prices have made solar more affordable than ever.
- Costs have been dropping due to public policy.

Figure 2.1 U.S. PV Installations and Average System Price, 2000-2013



Source: "Costs of Solar Photovoltaics." SEIA.

- The average price of a completed PV system has dropped by 33% since the beginning of 2011.
- In 2013, the price was ~\$3/W and there were 792 MW in residential, 1,112 MW in non-residential and 2,847 in utility installations.



## Overview

"The Carbon Footprint." *European Photovoltaic Industry Association (EPIA)*. March 2011. Web. 18 Apr 2015.

"IPCC, 2011: Summary for Policymakers." *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. n.d. Web. 15 Apr 2015.

### **How PV Works:**

"Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills." Joint publication of the *U.S. Environmental Protection Agency (EPA)* and the *National Renewable Energy Laboratory (NREL)*. Feb 2013. Web. 13 Apr 2015.

### *Diagram from:*

"Photovoltaics: Technologies, Cost, and Performance." SunShot Vision Study. U.S. Department of Energy. Feb 2012. Web. 16 Apr 2015.  
[http://www1.eere.energy.gov/solar/pdfs/47927\\_chapter4.pdf](http://www1.eere.energy.gov/solar/pdfs/47927_chapter4.pdf)

## Benefits, Policy, & the Future

### **Greenhouse Gas Emissions:**

"Environmental Impacts of Solar Power." *Union of Concerned Scientists*. Energy, Renewable Energy. Revised: March 5, 2013. Web. 15 Apr 2015.

### *Chart from:*

"The Carbon Footprint." *European Photovoltaic Industry Association (EPIA)*. March 2011. Web. 18 Apr 2015.

### **Policy:**

"Energy Policies of IEA Countries – The United States 2007 Review." Joint publication of the *International Energy Agency (IEA)* and the *Organization for Economic Co-Operation and Development (OECD)*. 2007. Web. 16 Apr 2015.

### **The Future:**

"The Carbon Footprint." *European Photovoltaic Industry Association (EPIA)*. March 2011. Web. 18 Apr 2015.

## PV Trends – US & Global

*Data for the U.S. Net Generation from Solar Photovoltaic graph from:*

*U.S. Energy Information Administration (eia)*. Independent Statistics & Analysis. *Electric Power Monthly*. Release Date 27 Mar 2015. Web. 18 Apr 2015.  
[http://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_1\\_01\\_a](http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_01_a)

*Data for the Global Net Generation from Solar Photovoltaic graph from:*

*U.S. Energy Information Administration (eia)*. International Energy Statistics. *Electricity Generation*. Web. 18 Apr 2015.  
<http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=6&pid=116&aid=12&cid=r1,r3,r7,&syid=2008&eyid=2012&unit=BKWH>

*Chart from:*

"Technology Roadmap: Solar Photovoltaic Energy – 2014 edition." *International Energy Agency (iea)*. Release date: Sept 2014. Web. 18 Apr 2014.  
<http://www.iea.org/publications/freepublications/publication/technology-roadmap-solar-photovoltaic-energy---2014-edition.html>

### **China:**

Topf, Andrew. "Why China is Leading the World in Solar Power." *Oil Price.com*. Alternative Energy: Solar Energy. 24 Aug 2014. Web. 19 Apr 2015.  
<http://oilprice.com/Alternative-Energy/Solar-Energy/Why-China-Is-Leading-The-World-In-Solar-Power.html>

*Chart from:*

"Costs of Solar Photovoltaics." *Solar Energy Industries Association (SEIA)*. Photovoltaic (Solar Electric), n.d. Web. 18 Apr 2014.  
<http://www.seia.org/policy/solar-technology/photovoltaic-solar-electric>